

CLAIMS

Sub 4) Having thus described our invention, what we claim as new and desire to secure by Letters Patent is as follows:

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- 1 Sub 4) 1. A multiple stage pump, comprising:
2 a first pump in a first stage;
3 a second pump in a second stage;
4 at least one valve upstream from one of the first pump and the second pump in at
5 least one of the first stage and the second stage; and
6 a common branch line connecting the first stage and the second stage to a
7 common hydraulic system.
- 1 2. The multiple stage pump of claim 1, wherein the at least one valve includes:
2 a first valve upstream of the first pump in the first stage of the hydraulic system;
3 and
4 a second valve upstream of the second pump in the second stage of the hydraulic
5 system.
- 1 3. The multiple stage pump of claim 1, further including:
2 at least another valve in direct line and upstream from the at least one valve; and
3 a valve system associated with the common branch line upstream from the
4 connection of the first stage and the second stage.
- 1 4. The multiple stage pump of claim 3, wherein
2 the at least one valve includes:
3 a first valve upstream of the first pump in the first stage of the hydraulic

4 *BS* system; and

5 a second valve upstream of the second pump in the second stage of the
6 hydraulic system; and

7 the at least another valve includes:

8 a first other valve upstream from the first valve; and

9 a second other valve upstream from the second valve.

1 5. The multiple stage pump of claim 1, wherein the at least one valve includes three
2 valves associated with both the first stage and the second stage.

1 6. The multiple stage pump of claim 1, wherein the at least one valve is one of a control
2 valve, a flow valve, a pressure control valve and an on/off valve.

1 7. The multiple stage pump of claim 1, further comprising
2 a first check valve associated with the first stage; and
3 a second check valve associated with the second stage, wherein
4 the first check valve is adapted to ensure that the second pump in the
5 second stage is not running against a low pressure of a valve of the at least one valve
6 associated with the second stage which is in an "off" position, and
7 the second check valve is adapted to ensure that the first pump in the first
8 stage is not running against a low pressure of a valve of the at least one valve associated
9 with the first stage which is in the "off" position.

1 8. A multiple stage pump, comprising:
2 at least two pumps; and
3 at least two valve means for regulating fluid from the at least two pumps,
4 respectively, the at least two valve means being upstream from the at least two pumps in

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5 *PS* a respectively same line as the at least two pumps.

1 9. The multiple stage pump of claim 8, further comprising a merged line upstream from
2 the at least two valve means.

1 10. The multiple stage pump of claim 9, wherein the at least two valve means are control
2 valves, flow valves or on/off valves.

1 11. The multiple stage pump of claim 9, wherein the at least two valve means are
2 pressure regulated valves.

1 12. The multiple stage pump of claim 9, wherein the at least two valve means are
2 pressure relief valves.

1 13. The multiple stage pump of claim 9, wherein the at least two valve means are each a
2 set of valves.

1 14. A pumping system adapted for supplying fluid to an injector, comprising:
2 a multiple stage pumping system having a multitude of pump stages for supplying
3 the fluid to the injector; and
4 a flow control system for providing a linear flow control throughout the multitude
5 of pump stages while preventing pressure peaks,
6 wherein for each pump stage a pressure control valve regulates the on/off function
7 of a multitude of volumes to supply the each pump stage with the fluid.

1 15. The pumping system of claim 14, further comprising a common branch rail
2 associated with the multiple stage pumping for supply the fluid to the injector, wherein

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3 *BS* the fluid flow passes a check valve after each pump stage before the fluid flow is
4 combined in the common branch line,
5 the check valves regulate switching without pressure peaks throughout the
6 multiple stage pumping system, and
7 the check valves ensure that an opposite side pump of the multiple stage pumping
8 system is not running against a low pressure of a valve which is in an "off" position.

1 16. The pumping system of claim 15, wherein the control valves are positioned in
2 parallel and in line to respective reservoirs thereby eliminating pressure drops.

1 17. The pumping system of claim 16, wherein a start position of any of the control valves
2 is a closed position to thus provide a fail safe position when any of the control valves
3 fails.

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